LIVING SYSTEMS
INSTRUMENTATION
innovations for vascular research

FLOW INDICATOR

USER'S MANUAL

FI-1 User's Manual
DOC-230
Rev. 1.1

Copyright © 2010
All Rights Reserved

www.livingsys.com

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

Chapter 1 1
Introduction 1
Principles of Operation 1
FI-1 Front and Back Panels 1
Compatible Infusion Pumps 2
Specifications 3
Chapter 2 4
Wiring Instructions 4
Wiring for Internally Controlling the Flow Rate 4
Wiring for Externally Controlling the Flow Rate 6
Chapter 3 8
Calibration Procedure 8
FC and PS-200-P (in Flow Mode) Calibration 8
Flow Indicator Calibration 10
Chapter 4 13
Operating Instructions 13
Living Systems Contact Information 14

CHAPTER 1
Introduction

The Living Systems Instrumentation (LSI) Flow Indicator is designed to monitor the flow rate of the LSI Flow Control Pump (model FC) or Pressure Servo Control Pump* (model PS-200-P). Once calibrated, the flow rate of the pump is displayed on the front panel of the FI-1 in µl/min, and is accessible as an analog output voltage at 10mV/µl/min for recording.

The flow rate of the pump may also be controlled via an external voltage applied to the **EXTERNAL FLOW INPUT** connector on the back of the FI-1. The voltage (0.0 to +9.9 VDC) applied to the FI-1 EXTERNAL FLOW INPUT connector is routed into the pump to control the flow rate.

*Note: Pressure Servo Control Pumps purchased before 1998 require a modest modification.

Principles of Operation

The volume of flow is proportional to the speed of the pump motor. The flow adjustment dials on each of the pumps are designed to be linear. That is, when the dial is set to half of the maximum, the pump speed and the volume flow are at half of maximum. The electrical signal that monitors the pump speed is calibrated (see Chapter 3 for calibration instructions) and used for the meter display and signal output.

FI-1 Front and Back Panels

Figure 1.1 – FI-1 Front Panel

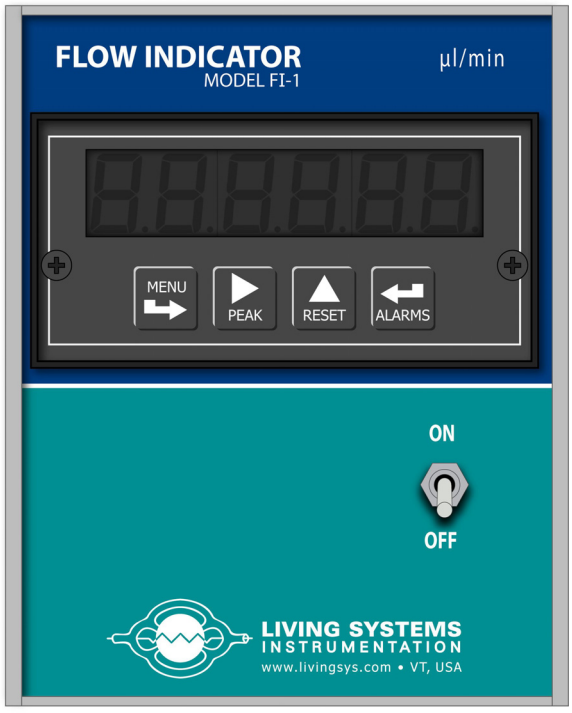
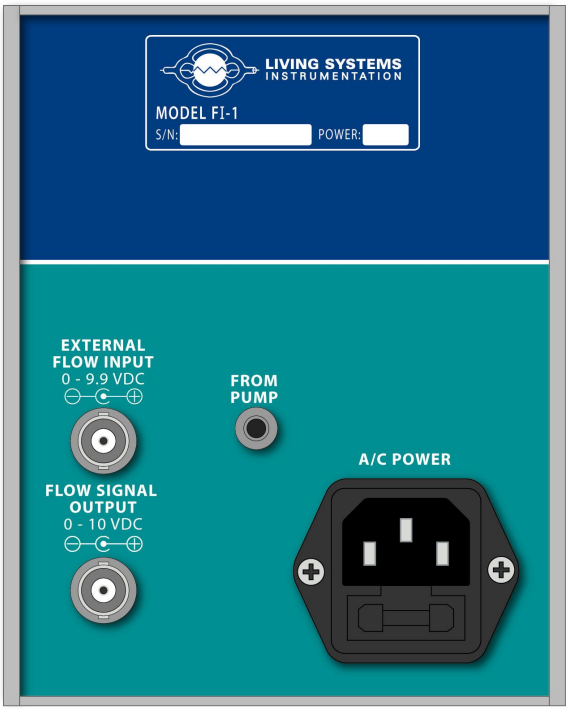


Figure 1.2 – FI-1 Back Panel



Compatible Infusion Pumps

Figure 1.3 – FC Flow Control Pump Front Panel

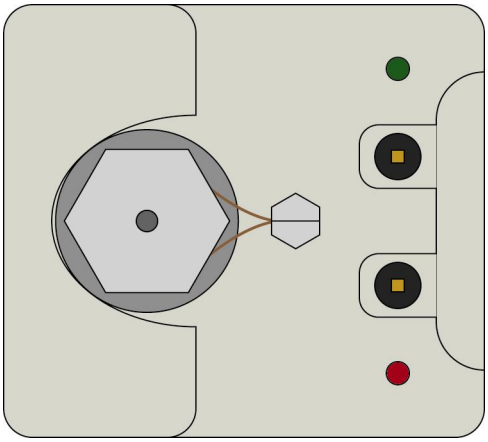
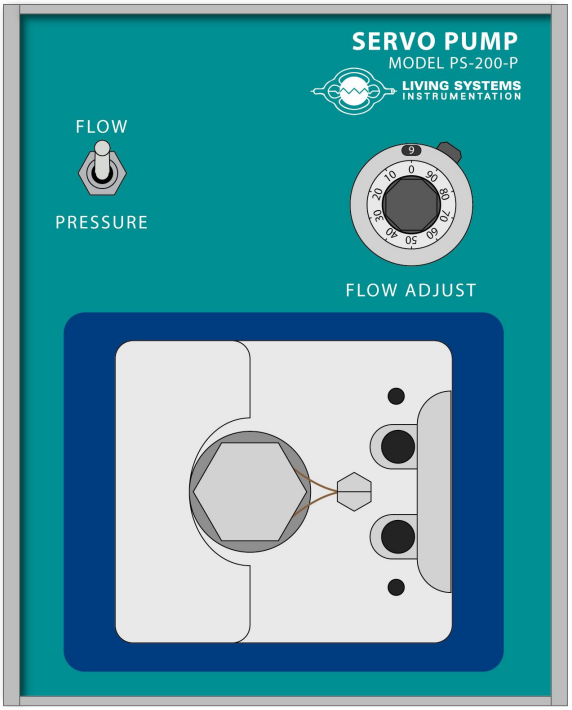


Figure 1.4 – PS-200-P Pump Front Panel



Specifications

Range: 0 – 2,500 µl/min

Output Updated: > 40 updates/second

Meter Resolution: ± 0.1 µl/min

Power Requirements: 100 – 120 VAC / 60 Hz or 200 – 240 VAC / 50 Hz
Auto detected and selected internally

Power Consumption: 5 watts

Maximum Amperage: 1 Amp

Fuse Type: 1 Amp, GMC Type, Medium Time Delay

Physical Size: 5.25 H x 4.25 W x 6 L in / 13 H x 11 W x 15 L cm

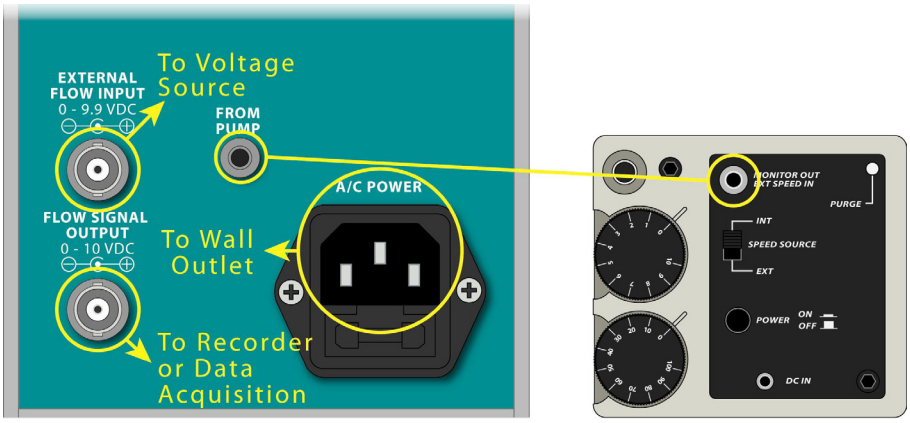
Weight: 1.5 lbs / 0.7 kg

CHAPTER 2
Wiring Instructions

Wiring for Internally Controlling the Flow Rate

FC Pump

Figure 2.1 – Wiring Diagram for Internally Controlling the Flow Rate of the FC Pump



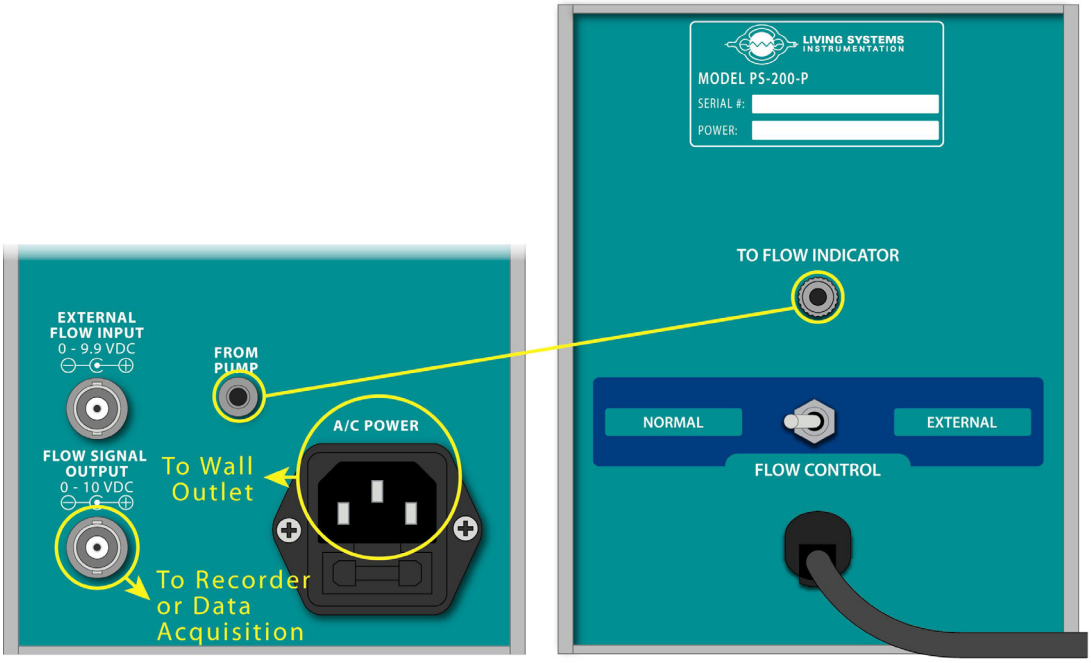
FI-1 BACK PANEL

FC PUMP BACK PANEL

1. Set the SPEED SOURCE switch on the back of the FC pump to **INT** (internal).
2. Using the included cable, connect the **FROM PUMP** connector on the back of the FI-1 to the **MONITOR OUT/EXT SPEED IN** connector on the back of the FC pump.
3. If desired, connect the **FLOW SIGNAL OUTPUT** BNC connector on the back of the FI-1 to a recorder or data acquisition device.
4. Using the included power cord, connect the **A/C POWER** connector on the back of the FI-1 to a standard wall outlet.

PS-200-P Pump

Figure 2.2 – Wiring Diagram for Internally Controlling the Flow Rate of the PS-200-P Pump

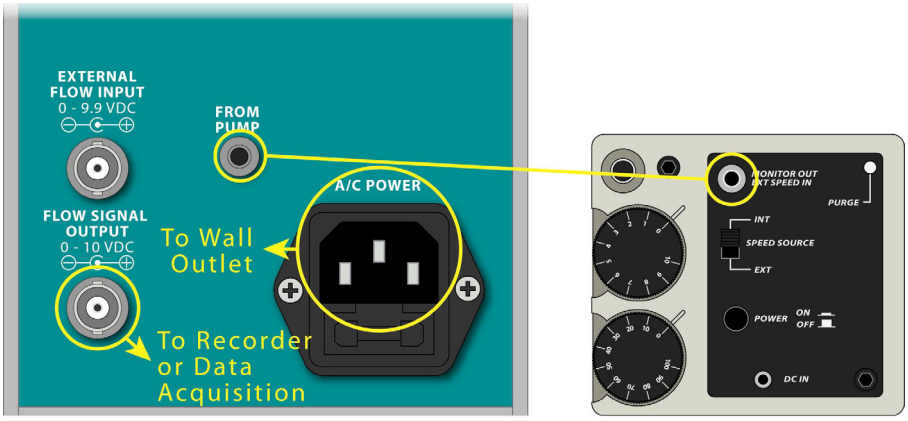


1. Set the FLOW CONTROL switch on the back of the PS-200-P pump to **NORMAL**.
2. Set the FLOW/PRESSURE switch on the front of the PS-200-P to **FLOW**, as shown in Figure 1.4.
3. Using the included cable, connect the **FROM PUMP** connector on the back of the FI-1 to the **TO FLOW INDICATOR** connector on the back of the PS-200-P pump.
4. If desired, connect the **FLOW SIGNAL OUTPUT** BNC connector on the back of the FI-1 to a recorder or data acquisition device.
5. Using the included power cord, connect the **A/C POWER** connector on the back of the FI-1 to a standard wall outlet.
6. Referring to the PS-200 User's Manual, connect the PS-200-P to the PS-200-S. This connection is important, as the PS-200-S supplies power to the PS-200-P.

Wiring for Externally Controlling the Flow Rate

FC Pump

Figure 2.3 – Wiring Diagram for Externally Controlling the Flow Rate of the FC Pump



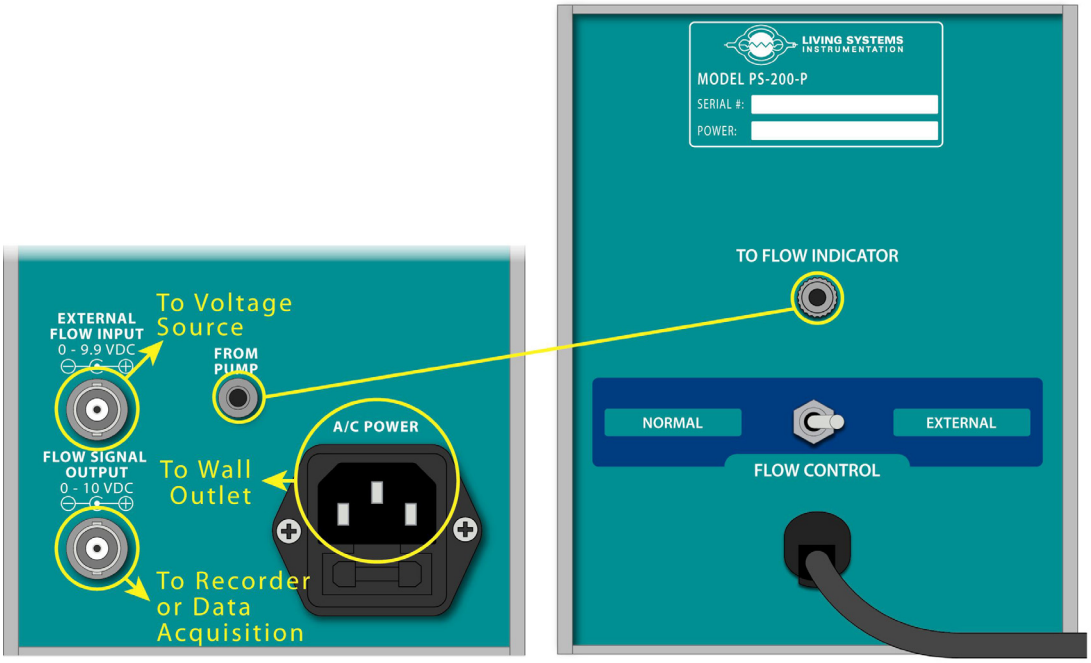
FI-1 BACK PANEL

FC PUMP BACK PANEL

1. Set the SPEED SOURCE switch on the back of the FC pump to **EXT** (external).
2. Using the included cable, connect the **FROM PUMP** connector on the back of the FI-1 to the **MONITOR OUT/EXT SPEED IN** connector on the back of the FC pump.
3. Using a BNC cable, connect the **EXTERNAL FLOW INPUT** connector on the back of the FI-1 to a voltage source. The voltage (0.0 to +9.9 VDC) applied to the FI-1 EXTERNAL FLOW INPUT is routed into the FC pump to control the flow rate. The relationship between the voltage and the flow rate can be monitored using the display on the front panel of the FI-1.
4. If desired, connect the **FLOW SIGNAL OUTPUT** BNC connector on the back of the FI-1 to a recorder or data acquisition device.
5. Using the included power cord, connect the **A/C POWER** connector on the back of the FI-1 to a standard wall outlet.

PS-200-P Pump

Figure 2.4 – Wiring Diagram for Externally Controlling the Flow Rate of the PS-200-P Pump



FI-1 BACK PANEL PS-200-P PUMP BACK PANEL

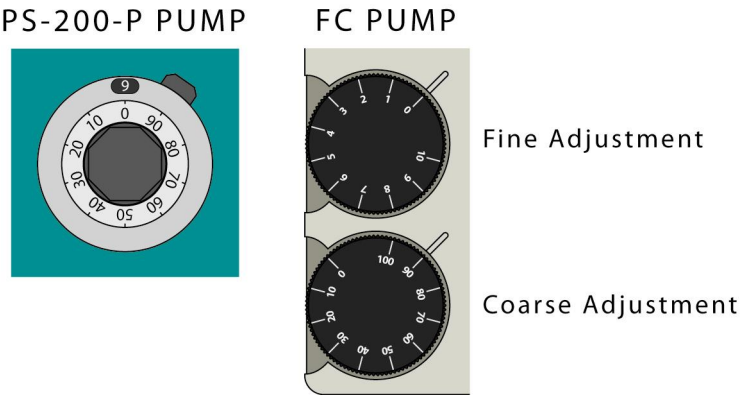
1. Set the FLOW CONTROL switch on the back of the PS-200-P pump to **EXTERNAL**.
2. Set the FLOW/PRESSURE switch on the front of the PS-200-P to **FLOW**, as shown in Figure 1.4.
3. Using the included cable, connect the **FROM PUMP** connector on the back of the FI-1 to the **TO FLOW INDICATOR** connector on the back of the PS-200-P pump.
4. Using a BNC cable, connect the **EXTERNAL FLOW INPUT** connector on the back of the FI-1 to a voltage source. The voltage (0.0 to +9.9 VDC) applied to the FI-1 EXTERNAL FLOW INPUT is routed into the PS-200-P pump to control the flow rate. The relationship between the voltage and the flow rate can be monitored using the display on the front panel of the FI-1.
5. If desired, connect the **FLOW SIGNAL OUTPUT** BNC connector on the back of the FI-1 to a recorder or data acquisition device.
6. Using the included power cord, connect the **A/C POWER** connector on the back of the FI-1 to a standard wall outlet.
7. Referring to the PS-200 User's Manual, connect the PS-200-P to the PS-200-S. This connection is important, as the PS-200-S supplies power to the PS-200-P.

CHAPTER 3
Calibration Procedure

FC and PS-200-P (in Flow Mode) Calibration

1. If using the FC pump, set the SPEED SOURCE switch on the back panel to **INT** (internal).
2. If using the PS-200-P pump, set the FLOW/PRESSURE switch on the front panel to **FLOW** and the FLOW CONTROL switch on the back panel to **NORMAL**.
3. Load a tube set into the pump and connect the inflow tube to a solution reservoir. If the tube set has never been used before, run the pump at full speed for 20-30 minutes to allow the tubing to stretch.
4. Select a container to collect the effluent fluid from the outflow tube. Weigh the empty container on a digital scale with 1 mg or better resolution. Record the container weight.
5. Set the flow adjustment knob on the pump to 90% of the maximum. If using the FC pump, the coarse adjustment should be set to **90** and the fine adjustment should be set to **0**, and on the PS-200-P the Flow Adjust knob should be set to **9.0**. These settings are illustrated in Figure 3.1.

Figure 3.1 – Flow Controls Set to 90% of Maximum



6. Run the pump for at least 15 minutes, collecting the effluent in the container.
7. At the end of the timed infusion, weigh the container. Record the container weight.
8. Subtract the weight of the empty container from the weight of the container plus the effluent.
9. Divide the difference by the duration of the infusion (in minutes).
10. The result is the **Calibrated Flow Rate** in μl/min. This value is used to calibrate the FI-1 Flow Indicator.

A	B	T	Calibrated Flow Rate (µl/min)
Container Weight (mg)	Container + Effluent Weight (mg)	Infusion Duration (minutes)	$\frac{B - A}{T}$

Example

An example calibration procedure is shown below.

If the measurements are as follows:

A = Container Weight = 29.327 g
B = Container + Effluent Weight = 33.543 g
T = Infusion Duration in minutes = 15

Then the first step is to convert grams to milligrams:
A = (29.327 g)(1000 mg/g) = 29,327 mg
B = (33.543 g)(1000 mg/g) = 33,543 mg

A	B	T	Calibrated Flow Rate (µl/min)
Container Weight (mg)	Container + Effluent Weight (mg)	Infusion Duration (minutes)	$\frac{B - A}{T}$
29.327	33.543	15	281

Now, to find the **calibrated flow rate (µl/min)** use (B – A)/T

(33,543 mg – 29,327 mg)/(15 min) = (4,216 mg)/(15 min) = **281 mg/min**

Using, 1 mg = 1 µl

281 mg/min = 281 µl/min

Therefore, 281 µl/min is the **calibrated flow rate.**

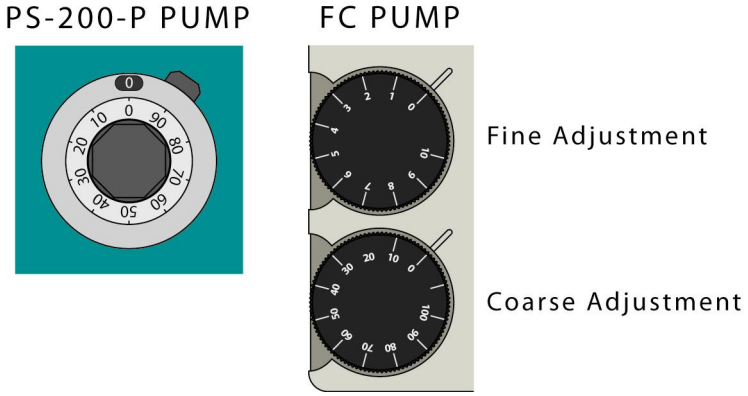
Flow Indicator Calibration

1. Connect the pump to the FI-1 according to the Wiring for Internally Controlling the Flow Rate section of Chapter 2.
2. Turn on the pump and the Flow Indicator. The Flow Indicator display will read **RESET**, as shown below.

Figure 3.2 – Turn on the FI-1 and the Display Reads RESET

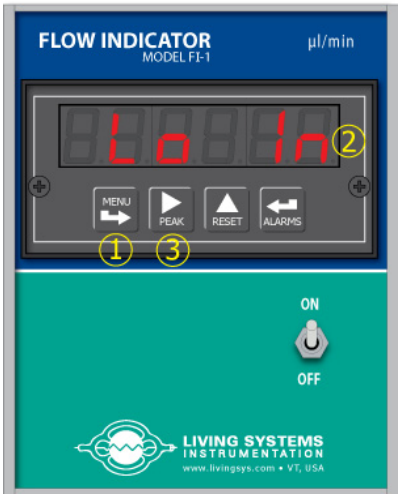
3. Set the pump to zero flow, as shown below.

Figure 3.3 - Flow Controls Set to Zero



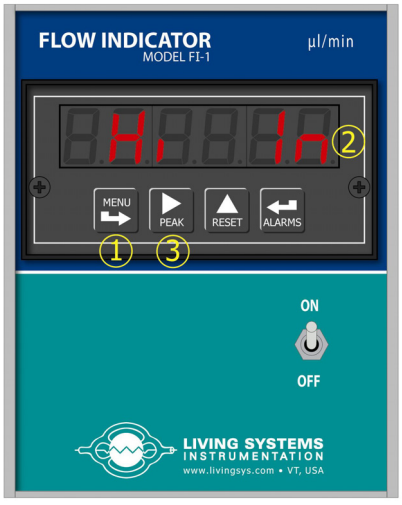
4. Press the MENU button. The display will read **Lo In**. Press the PEAK button, as shown.

*Figure 3.4 – Press **MENU**, Display Says **Lo In**, Press **PEAK***



5. The display should read approximately **0.0**. Press the RESET button and the display will momentarily read **STORE** as this voltage is stored as that which corresponds to zero flow.
6. Once again, set the flow adjustment knob on the pump to 90% of the maximum, as shown in Figure 3.1.
7. Press the MENU button. The display will read **Hi In**. Press the PEAK button, as shown.

*Figure 3.5 – Press **MENU**, Display Says **Hi In**, Press **PEAK***



8. The display now shows the voltage that corresponds to this pump speed. Press the ▲ RESET button and the display will momentarily read **STORE** as this voltage is stored as that which corresponds to the calibrated flow.
9. Press the MENU ➡ button. The display will read **Lo rd** (low reading). Press the ▶ PEAK button and the current flow rate of 0.0 μl/min will be displayed.
10. Press the MENU ➡ button again and the display will read **Hi rd** (high reading). This value must be set to the **Calibrated Flow Rate** determined in the **FC and PS-200-P (in Flow Mode) Calibration** procedure above. Press the ▶ PEAK button to highlight the first digit on the display. Using the ▲ RESET button, set this to the correct digit, and then press the ▶ PEAK button again to highlight the next digit to the right. Repeat using these two buttons to set the third digit.
11. Once the Calibrated Flow Rate is on the display, press the MENU ➡ button several times until the display reads **RESET**. The calibration is now complete and the display on the FI-1 will show the infusion rate in μl/min.
12. The calibration information will be retained when the FI-1 is turned off. Therefore, as long as the tubing set has not been changed, the flow reading will be correct when the instrument is turned on again. The calibration procedure should be repeated periodically and whenever the tubing set is changed.

CHAPTER 4
Operating Instructions

Operation of the FI-1 Flow Indicator is achieved using the display and the four pushbuttons on the front panel. Menus appear on the display and selections are made using the pushbuttons.

Connect the FI-1 to the pump according to the directions outlined in **Chapter 2** of this manual. If necessary, perform the calibration procedure outlined in **Chapter 3** of this manual.

Turn on the FI-1 using the **ON/OFF** switch on the front panel. The screen will display RESET momentarily, as shown in Figure 3.2, and then it will display the flow rate in μl/min.

If the value on the display is incorrect, verify that the pump is turned on and connected properly.

LIVING SYSTEMS CONTACT INFORMATION

Please feel free to contact the staff at Living System Instrumentation at any time.

Living Systems Instrumentation, Inc.
A division of Catamount Research & Development
802.863.5547 · 802.863.8057 (fax) · info@livingsys.com · www.livingsys.com